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(54) **APPLICATION STATE SYNCHRONIZATION
ACROSS MULTIPLE DEVICES**

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(56) **References Cited**

U.S. PATENT DOCUMENTS

6,811,486 B1 * 11/2004 Luciano, Jr. 463/24
7,315,740 B2 1/2008 Maes

(Continued)

OTHER PUBLICATIONS

“Data Synchronization Patterns in Mobile Application Design”—
McCormick et al, Vanderbilt Univ., May 2012 <https://www.dre.vanderbilt.edu/~schmidt/PDF/PatternPaperV11.pdf>.*

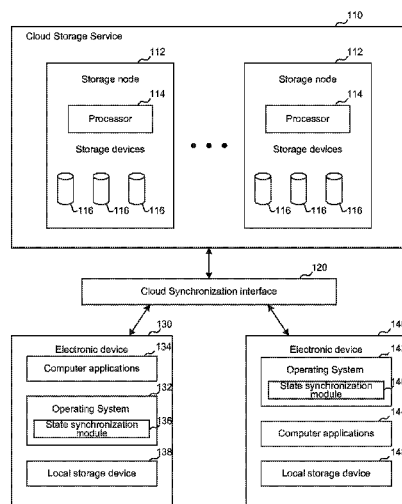
(Continued)

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(57) **ABSTRACT**

Techniques for a method for automatically synchronizing application state across multiple devices are disclosed herein. The method includes running an instance of a computer application on an electronic device, automatically determining a sync event that occurs in the electronic device, wherein the sync event suggests a synchronization of application state data and the application state data represent an application state of the computer application at the sync event, and transmitting the application state data of the computer application to a storage server in response to the sync event. The application state data of the computer application enables another instance of the computer application to resume the application state at the sync event at another electronic device.

30 Claims, 6 Drawing Sheets



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(56)

References Cited

U.S. PATENT DOCUMENTS

7,326,117 B1 2/2008 Best
 7,490,045 B1 2/2009 Flores et al.
 7,774,457 B1 8/2010 Talwar et al.
 7,903,383 B2 3/2011 Fukano et al.
 8,005,956 B2 8/2011 Williams et al.
 8,234,348 B1 7/2012 Tulchinsky et al.
 8,290,920 B2 10/2012 Mahajan et al.
 8,315,977 B2 11/2012 Anand et al.
 8,423,511 B1 4/2013 Bhatia
 8,438,298 B2 5/2013 Arai et al.
 8,473,577 B2 6/2013 Chan
 8,475,275 B2 7/2013 Weston et al.
 8,478,816 B2 7/2013 Parks et al.
 8,494,576 B1 7/2013 Bye et al.
 8,495,129 B2 7/2013 Wolman et al.
 8,515,902 B2 8/2013 Savage
 8,539,567 B1* 9/2013 Logue et al. 726/7
 8,589,140 B1 11/2013 Poulin
 8,606,948 B2 12/2013 Evans et al.
 8,666,938 B1 3/2014 Pancholy
 8,747,232 B1 6/2014 Quan et al.
 8,775,449 B2 7/2014 Quan et al.
 8,812,601 B2 8/2014 Hsieh et al.
 2001/0039212 A1 11/2001 Sawano et al.
 2002/0161908 A1 10/2002 Benitez et al.
 2004/0018876 A1 1/2004 Kubota et al.
 2005/0147130 A1* 7/2005 Hurwitz et al. 370/503
 2006/0030408 A1* 2/2006 Kiiskinen 463/42
 2006/0073788 A1* 4/2006 Halkka et al. 455/41.2
 2007/0130217 A1* 6/2007 Linyard et al. 707/201
 2008/0055311 A1 3/2008 Aleksic et al.
 2008/0220878 A1 9/2008 Michaelis
 2009/0063690 A1 3/2009 Verthein et al.
 2009/0077263 A1 3/2009 Koganti et al.
 2009/0106110 A1 4/2009 Stannard et al.
 2009/0204966 A1 8/2009 Johnson et al.
 2009/0282125 A1 11/2009 Jeide et al.
 2010/0173712 A1 7/2010 Buhr
 2010/0235511 A1 9/2010 Kai
 2010/0257403 A1 10/2010 Virk et al.
 2010/0332401 A1 12/2010 Prahlad et al.
 2011/0078319 A1 3/2011 Ishida
 2011/0093567 A1 4/2011 Jeon et al.
 2011/0126168 A1 5/2011 Ilyayev
 2011/0219105 A1 9/2011 Kryze et al.
 2011/0252071 A1 10/2011 Cidon
 2011/0275316 A1 11/2011 Suumäki et al.
 2011/0286026 A1 11/2011 Matsuzawa
 2012/0017236 A1 1/2012 Stafford et al.
 2012/0023250 A1 1/2012 Chen et al.
 2012/0028714 A1 2/2012 Gagner et al.
 2012/0036218 A1 2/2012 Oh et al.
 2012/0036239 A1 2/2012 Donaghey et al.
 2012/0079095 A1 3/2012 Evans et al.
 2012/0079126 A1 3/2012 Evans et al.
 2012/0084803 A1 4/2012 Johansson et al.
 2012/0110568 A1 5/2012 Abel et al.
 2012/0128172 A1 5/2012 Alden
 2012/0149309 A1 6/2012 Hubner et al.
 2012/0171951 A1 7/2012 t Hooft
 2012/0203932 A1 8/2012 da Costa et al.
 2012/0210343 A1 8/2012 McCoy et al.
 2012/0303778 A1 11/2012 Ahiska et al.
 2012/0311820 A1 12/2012 Chang
 2013/0007203 A1 1/2013 Szu

2013/0008611 A1 1/2013 Marcus et al.
 2013/0044106 A1 2/2013 Shuster et al.
 2013/0045795 A1 2/2013 Fiedler
 2013/0086114 A1* 4/2013 Wilson et al. 707/783
 2013/0117806 A1 5/2013 Parthasarathy et al.
 2013/0159890 A1 6/2013 Rossi
 2013/0219381 A1 8/2013 Lovitt
 2013/0223240 A1 8/2013 Hayes et al.
 2013/0225087 A1 8/2013 Uhm
 2013/0304898 A1 11/2013 Aggarwal et al.
 2014/0040239 A1 2/2014 Hirsch
 2014/0053054 A1 2/2014 Shen et al.
 2014/0101300 A1 4/2014 Rosensweig et al.
 2014/0170978 A1 6/2014 Wolman et al.
 2014/0379853 A1 12/2014 Shelton

OTHER PUBLICATIONS

Co-Pending Design U.S. Appl. No. 29/486,424 by Chan, M.A., et al., filed Mar. 28, 2014.
 Co-Pending U.S. Appl. No. 14/042,398 by Chan, M.A., et al., filed Sep. 30, 2013.
 Co-Pending U.S. Appl. No. 14/042,567 by Chan, M.A., et al., filed Sep. 30, 2013.
 Co-Pending U.S. Appl. No. 14/221,174 by Chan, M.A., et al., filed Mar. 20, 2014.
 Co-Pending U.S. Appl. No. 14/228,190 by Quan, J., et al., filed Mar. 27, 2014.
 Co-Pending U.S. Appl. No. 14/251,463 by Quart, J., et al., filed Apr. 11, 2014.
 Co-Pending U.S. Appl. No. 14/252,674 by Chart M.A., et al., filed Apr. 14, 2014.
 Co-Pending U.S. Appl. No. 14/267,823 by Chan, M.A., et al., filed May 1, 2014.
 Non-Final Office Action mailed Apr. 2, 2014, U.S. Appl. No. 14/179,709 by Quart, J., et al., filed Feb. 13, 2014.
 Non-Final Office Action mailed Apr. 3, 2014, U.S. Appl. No. 14/158,682 by Quan, J., et al., filed Jan. 17, 2004.
 Notice of Allowance mailed Apr. 15, 2014, Co-pending U.S. Appl. No. 14/167,834, by Quan et al., filed Jan. 29, 2014.
 Non-Final Office Action mailed May 27, 2014, U.S. Appl. No. 14/158,733 by Quan, J., et al., filed Jan. 17, 2014.
 Non-Final Office Action mailed Jun. 9, 2014, for U.S. Appl. No. 14/167,939 by Quan, J., et al., filed Jan. 29, 2014.
 Restriction Requirement mailed Jun. 12, 2014, for U.S. Appl. No. 14/251,463 by Quan, J., et al., filed Apr. 11, 2014.
 Co-Pending U.S. Appl. No. 14/179,709 by Quan, J., et al., filed Feb. 13, 2014.
 Co-Pending U.S. Appl. No. 14/179,744 by Quan, J., et al., filed Feb. 13, 2014.
 Non-Final Office Action mailed Mar. 7, 2014, Co-pending U.S. Appl. No. 14/158,715, by Quan et al., filed Jan. 17, 2014.
 Non-Final Office Action mailed Mar. 10, 2014, Co-pending U.S. Appl. No. 14/173,680, by Quan et al., filed Feb. 5, 2014.
 Co-Pending U.S. Appl. No. 14/043,034 by Chan, M.A., et al., filed Oct. 1, 2013.
 Co-Pending U.S. Appl. No. 14/158,682 by Quan, J., et al., filed Jan. 17, 2004.
 Co-Pending U.S. Appl. No. 14/158,715 by Quan, J., et al., filed Jan. 17, 2014.
 Co-Pending U.S. Appl. No. 14/173,680 by Quan, J., et al., filed Feb. 5, 2014.
 Co-Pending U.S. Appl. No. 14/167,834 by Quan, J., et al., filed Jan. 29, 2014.
 Co-Pending U.S. Appl. No. 13/865,515 by Quan, J., et al., filed Apr. 18, 2013.
 Co-Pending U.S. Appl. No. 14/158,733 by Quan, J., et al., filed Jan. 17, 2014.
 Co-Pending U.S. Appl. No. 14/160,444 by Quan, J., et al., filed Jan. 21, 2014.
 Co-Pending U.S. Appl. No. 14/167,939 by Quan, J., et al., filed Jan. 29, 2014.
 Co-Pending U.S. Appl. No. 14/042,509 by Chan, M.A., et al., filed Sep. 30, 2013.

(56)

References Cited

OTHER PUBLICATIONS

International Search Report and Written Opinion mailed Feb. 3, 2014, 7 pp., for International Application No. PCT/US13/62729 filed Sep. 30, 2013.

International Search Report and Written Opinion mailed Feb. 3, 2014, 9 pp., for International Application No. PCT/US13/62986 filed Oct. 2, 2013.

International Search Report and Written Opinion mailed Feb. 3, 2014, 7 pp., for International Application No. PCT/2013/62737 filed Sep. 30, 2013.

Non-Final Office Action mailed May 8, 2014, U.S. Appl. No. 14/179,744 by Quan, J., et al., filed Feb. 13, 2014.

Non-Final Office Action mailed May 9, 2014, U.S. Appl. No. 14/160,444 by Quan, J., et al., filed Jan. 21, 2014.

Notice of Allowance mailed May 14, 2014, Co-pending U.S. Appl. No. 14/158,715, by Quan et al., filed Jan. 17, 2014.

Notice of Allowance mailed May 20, 2014, Co-pending U.S. Appl. No. 14/173,680, by Quan et al., filed Feb. 5, 2014.

Final Office Action mailed Jul. 24, 2014, U.S. Appl. No. 14/179,709 by Quan, J., et al., filed Feb. 13, 2014.

Final Office Action mailed Nov. 6, 2014, U.S. Appl. No. 14/158,682 by Quan, J., et al., filed Jan. 17, 2004.

International Search Report mailed Sep. 11, 2014, 7 pps., for International Application No. PCT/US2013/031488 filed Mar. 21, 2014.

Layton, J.B., "User Space File Systems," Linux Magazine, accessed at <http://www.linux-mag.com/id/7814>, Jun. 22, 2010, pp. 1-4.

Non Final Office Action mailed Oct. 23, 2014, for U.S. Appl. No. 14/252,674 by Chan, M.A., et al., filed Apr. 14, 2014.

Non-Final Office Action mailed Aug. 26, 2014, for U.S. Appl. No. 14/267,823 by Chan, M.A., et al., filed May 1, 2014.

Notice of Allowance mailed Aug. 12, 2014, U.S. Appl. No. 14/179,709 by Quan, J., et al., filed Feb. 13, 2014.

Notice of Allowance mailed Sep. 3, 2014, U.S. Appl. No. 14/160,444 by Quan, J., et al., filed Jan. 21, 2014.

Restriction Requirement mailed Aug. 29, 2014, for U.S. Appl. No. 14/252,674 by Chan, M.A., et al., filed Apr. 14, 2014.

U.S. Appl. No. 14/479,087 by Chan, M.A et al., filed Sep. 5, 2014.

U.S. Appl. No. 14/479,140 by Chan, M.A et al., filed Sep. 5, 2014.

McCormick, Z. and Schmidt, D. C., "Data Synchronization Patterns in Mobile Application Design," Vanderbilt University, pp. 1-14 (2012).

Notice of Allowance mailed Oct. 29, 2014, for U.S. Appl. No. 14/167,939 by Quan, J., et al., filed Jan. 29, 2014.

Notice of Allowance mailed Oct. 29, 2014, for U.S. Appl. No. 14/179,744 by Quan, J., et al., filed Feb. 13, 2014.

Notice of Allowance mailed Nov. 25, 2014, for U.S. Appl. No. 14/252,674 by Chan, M.A., et al., filed Apr. 14, 2014.

Non Final Office Action mailed Dec. 3, 2014, for U.S. Appl. No. 14/251,463 by Quan, J., et al., filed Apr. 11, 2014.

Notice of Allowance mailed Dec. 4, 2014, for U.S. Appl. No. 14/479,140 by Chan, M.A., et al., filed Sep. 5, 2014.

Notice of Allowance mailed Dec. 12, 2014, for U.S. Appl. No. 14/479,140 by Chan, M.A., et al., filed Sep. 5, 2014.

Notice of Allowance mailed Dec. 17, 2014, for U.S. Appl. No. 14/267,823 by Chan, M.A., et al., filed May 1, 2014.

Notice of Allowance mailed Dec. 19, 2014, for U.S. Appl. No. 14/479,140 by Chan, M.A., et al., filed Sep. 5, 2014.

Notice of Allowance mailed Dec. 22, 2014, for U.S. Appl. No. 14/179,744 by Quan, J., et al., filed Feb. 13, 2014.

Final Office Action mailed Dec. 23, 2014, for U.S. Appl. No. 14/158,733 by Quan, J., et al., filed Jan. 17, 2014.

Notice of Allowance mailed on Mar. 17, 2015, for U.S. Appl. No. 14/158,733, Quan, J., et al., filed Jan. 17, 2014.

Notice of Allowance mailed on Mar. 30, 2015, for U.S. Appl. No. 14/267,823, Chan, M.A., et al., filed on May 1, 2014.

Non-Final Office Action mailed Apr. 8, 2015, for U.S. Appl. No. 14/228,190, Quan, J., et al., filed on Mar. 27, 2014.

Non-Final Office Action mailed on Apr. 8, 2015, for U.S. Appl. No. 13/865,515, Quan, J., et al., filed on Apr. 18, 2013.

Notice of Allowance mailed on Apr. 15, 2015, U.S. Patent Appl. No. 14/479,140, Chan, M.A., et al., filed on Sep. 5, 2014.

Non-Final Office Action mailed May 15, 2015, for U.S. Appl. No. 14/042,398, by Chan, M.A., et al., filed Sep. 30, 2013.

Non-Final Office Action mailed Jun. 22, 2015, for U.S. Appl. No. 14/043,034, of Quan, J., et al., filed Oct. 1, 2013.

Non-Final Office Action mailed Jun. 22, 2015, for U.S. Appl. No. 14/158,682, of Quan, J., et al., filed Jan. 17, 2014.

* cited by examiner

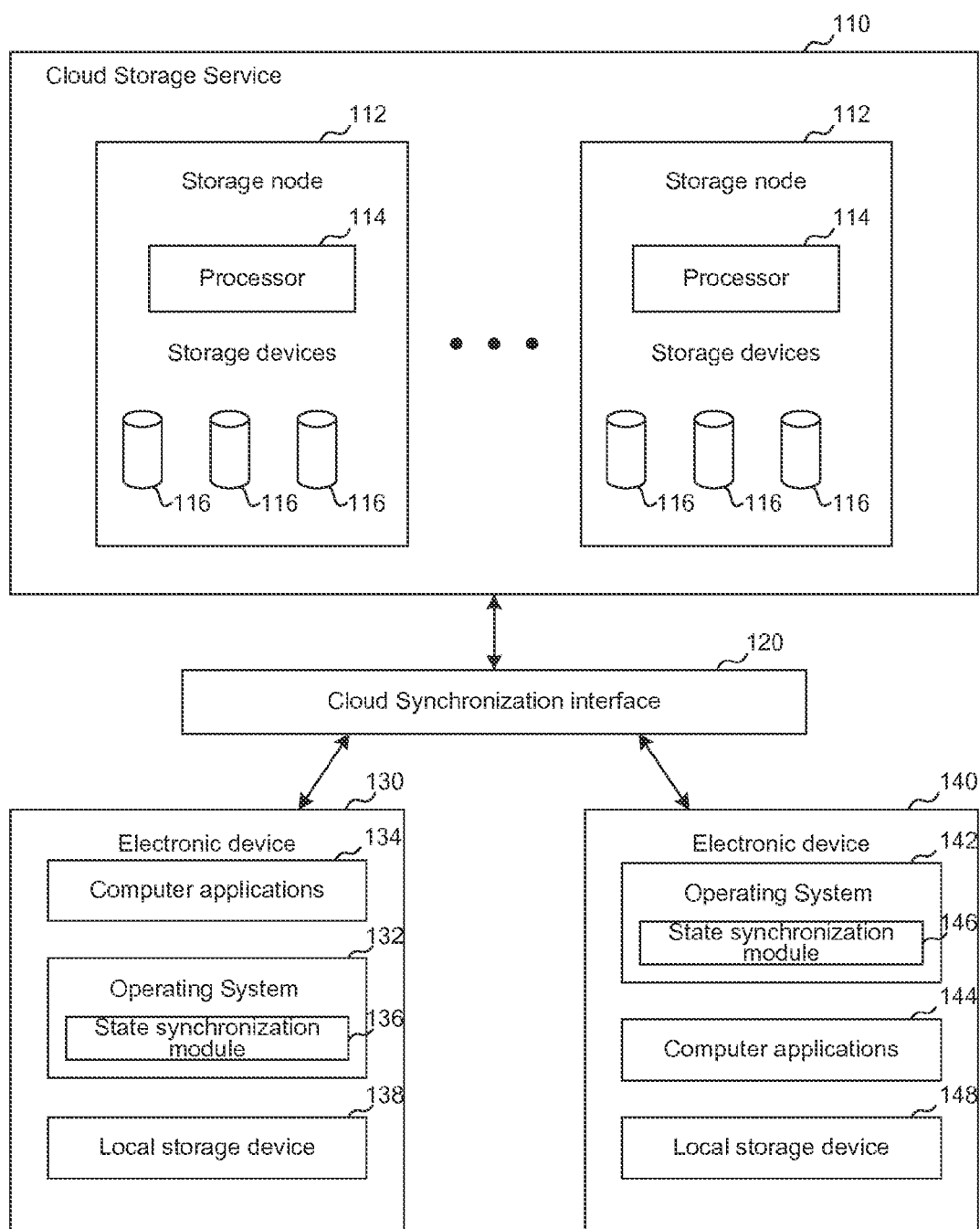
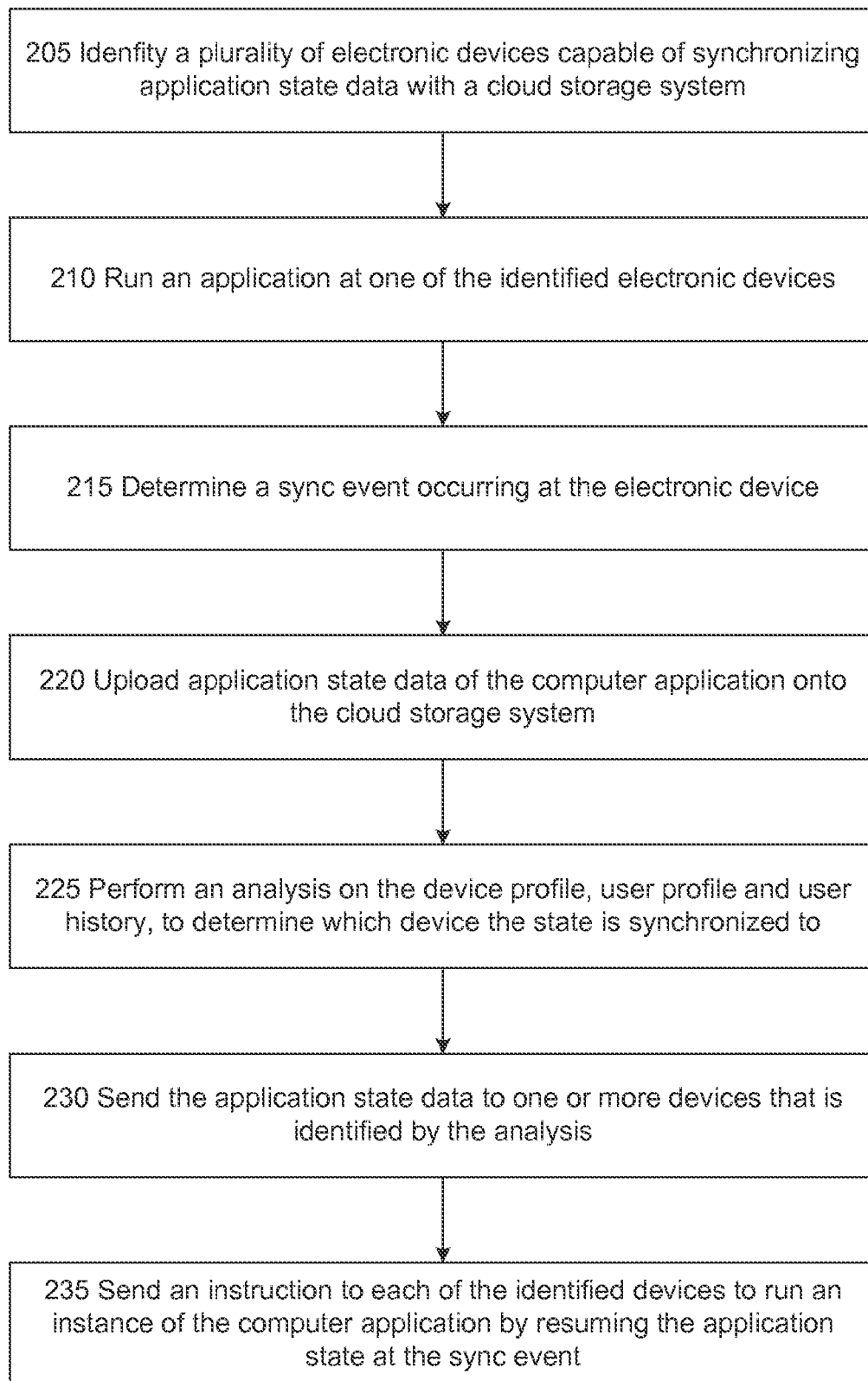
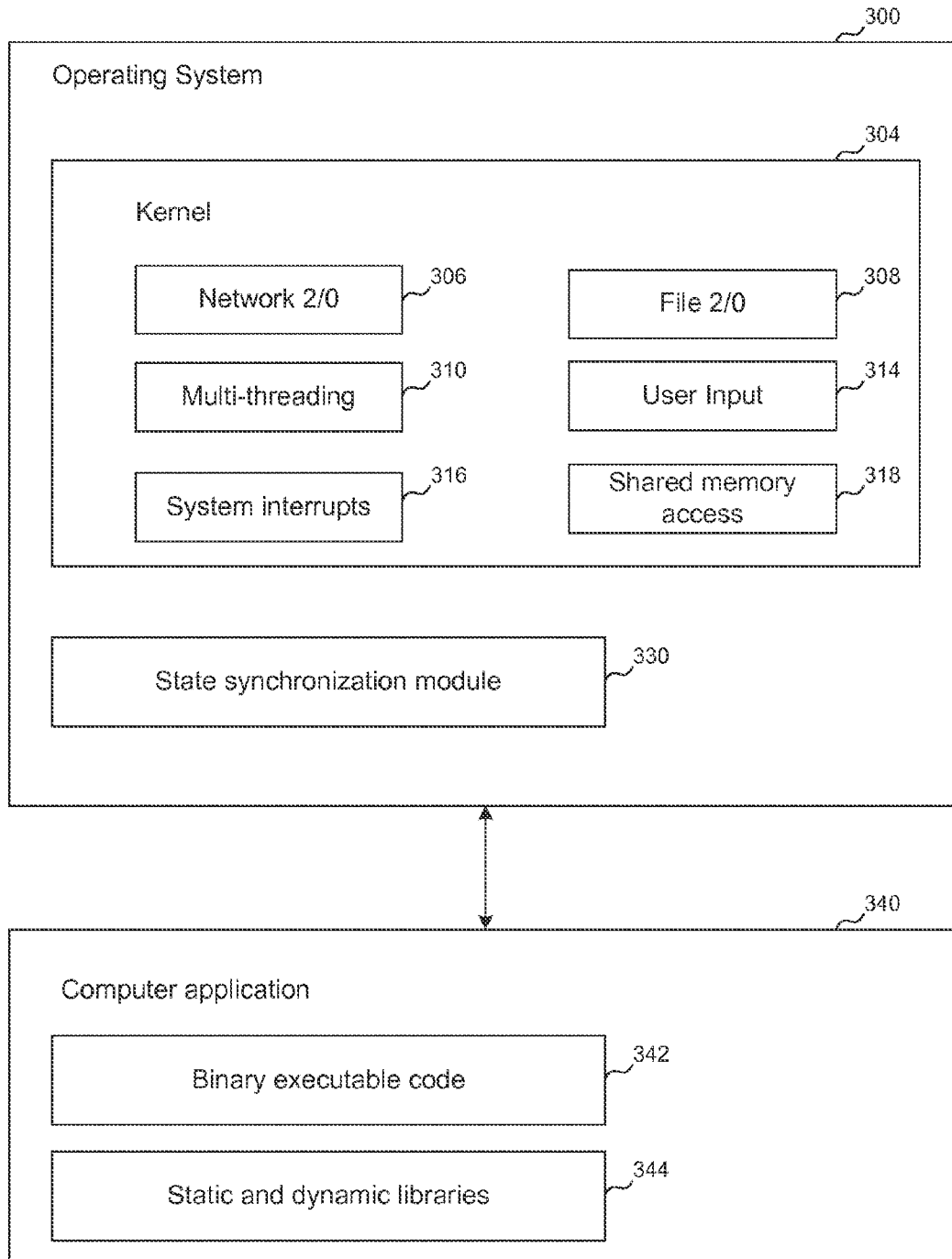
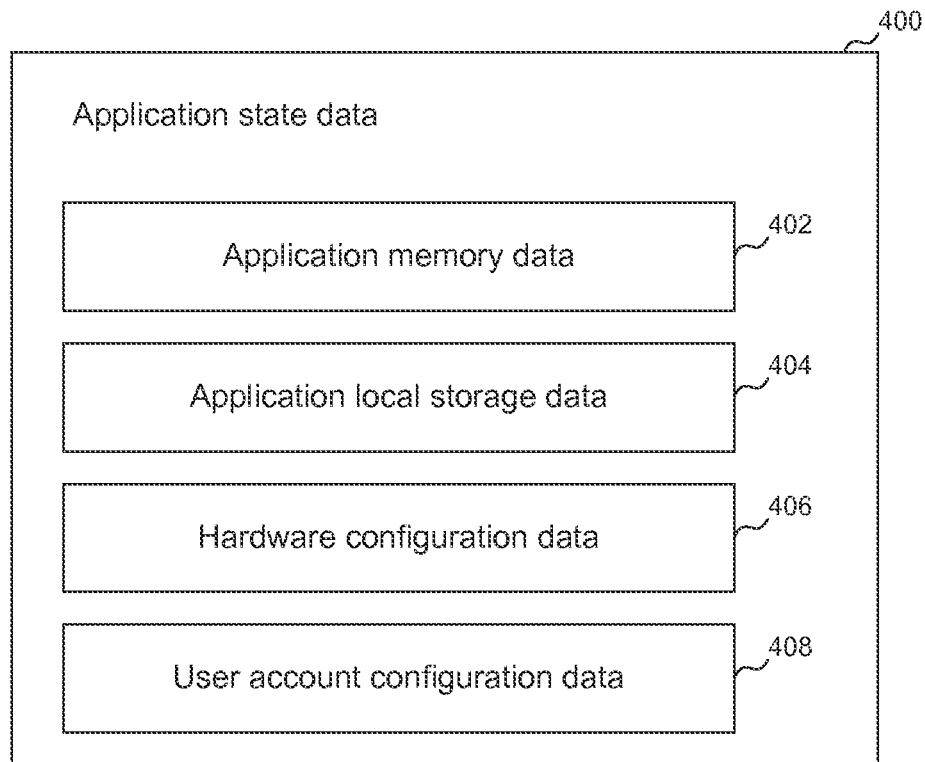
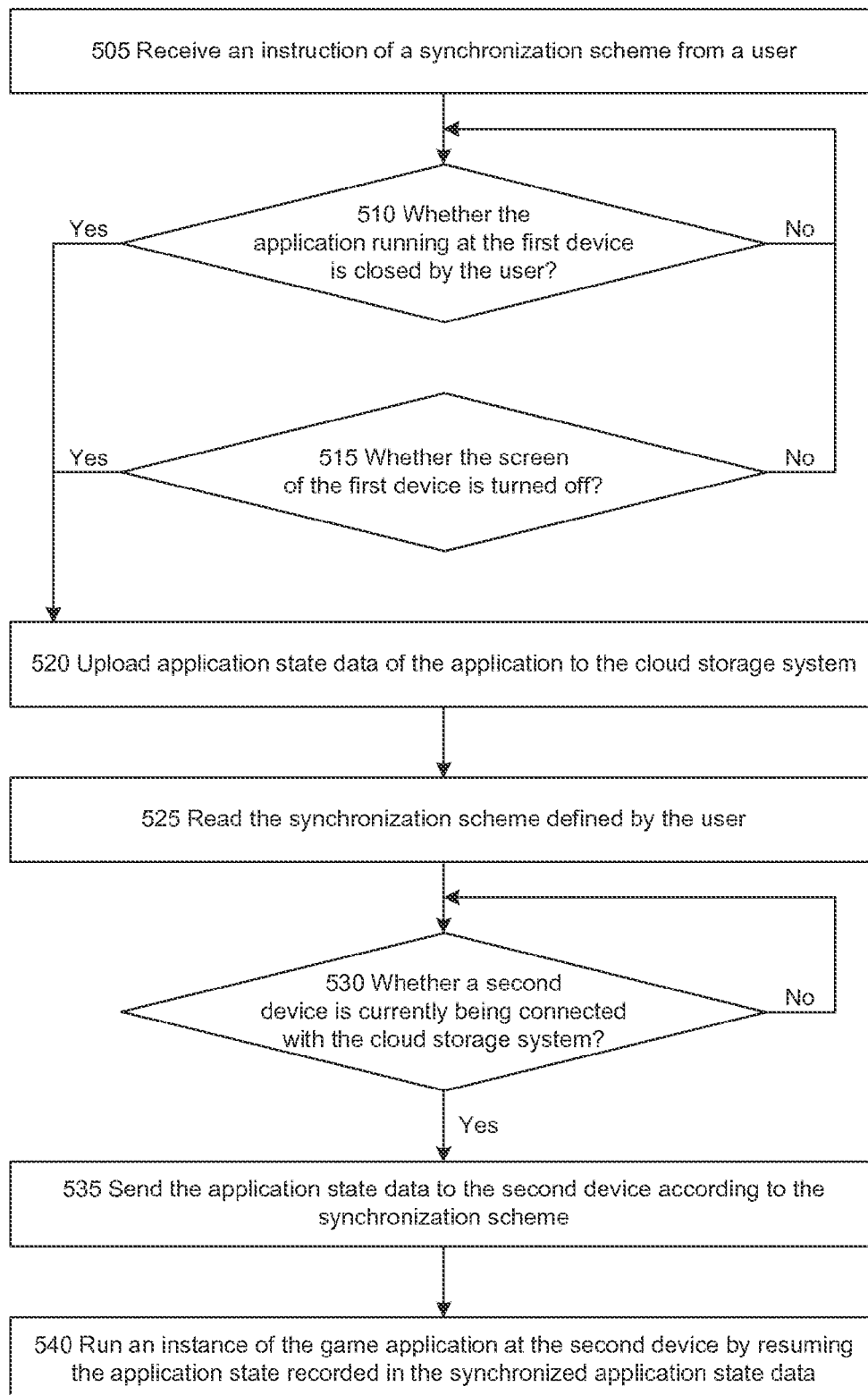


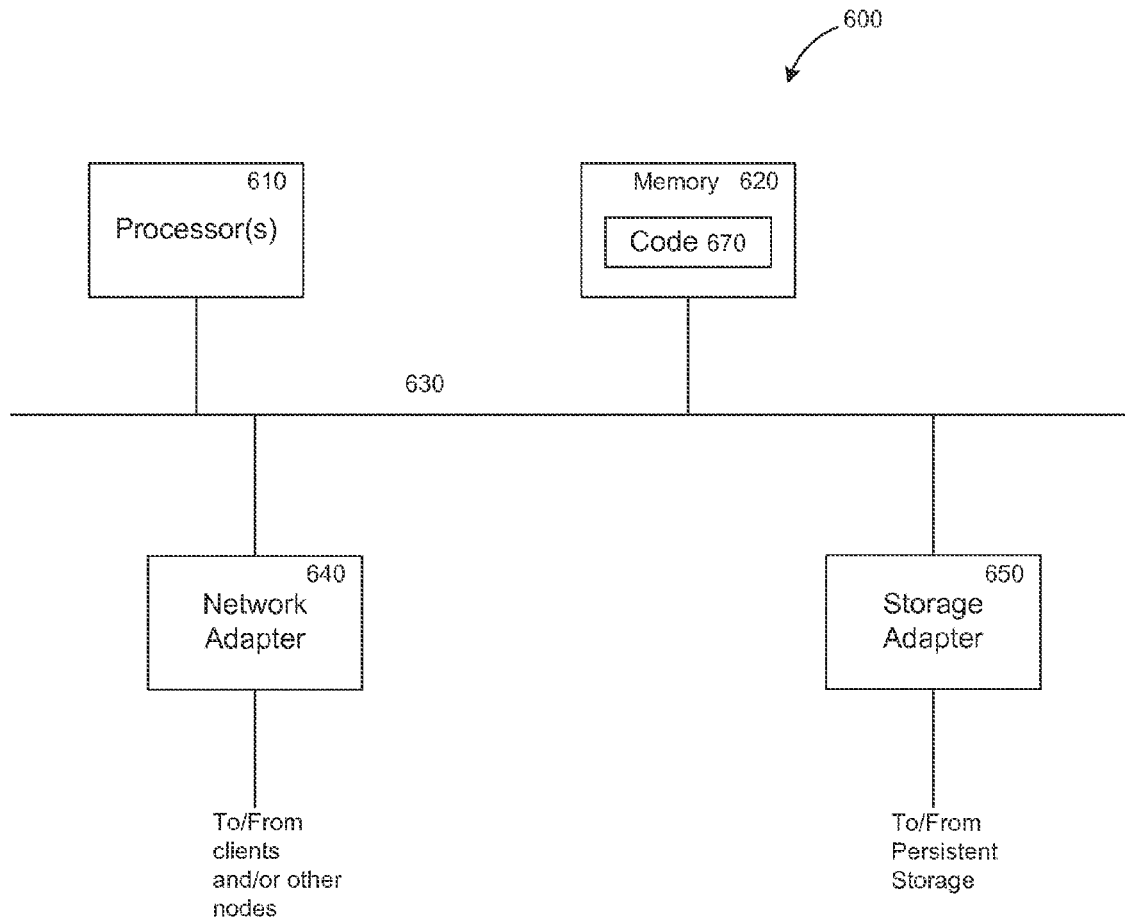
FIG. 1

**FIG. 2**

**FIG. 3**

**FIG. 4**

**FIG. 5**

**FIG. 6**

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APPLICATION STATE SYNCHRONIZATION ACROSS MULTIPLE DEVICES

PRIORITY CLAIM

This application claims to the benefit of U.S. Provisional Patent Application No. 61/708,794, entitled "CLOUD COMPUTING INTEGRATED OPERATING SYSTEM", which was filed on Oct. 2, 2012, which is incorporated by reference herein in its entirety.

FIELD OF THE INVENTION

At least one embodiment of the present invention pertains to cloud computing, and more particularly, to automatic synchronization of application states across multiple devices using cloud storage.

BACKGROUND

Application state data are data used to record the running status of a computer application. One example of application state data is a game save for a game application. A game save is a piece of digitally stored information about the progress of a user operating the game application. The game save can be reloaded later, so that the user can continue where he stopped. The user instructs the game application to generate a game save (i.e. save the game) to prevent the loss of progress in the game, especially when he is interrupted or ending a game session.

Sharing game saves among users has been common for many years. Originally by swapping memory cards with game saves, users could help each other to unlock features in a game application. With the growing popularity of the Internet, users start to upload their game saves from their devices to Internet servers. By downloading a game save from an Internet server, a user can continue the progress of the game on the device on which he played the game or another device such as a computer, game console, or smart phone. However, to achieve the goal of continuing the progress on another device, the user needs to deliberately instruct the device to save the game progress (i.e. game save) and to upload the game save to a server or a memory card. Then the user needs to download the game from the server or the memory card to the other device, and then instructs the other device to load the game save. The whole process is tedious and requires many user interventions. Furthermore, the process only works for game applications that are specifically designed with game saving functionalities.

SUMMARY

Techniques introduced here provide an automatic mechanism for synchronizing application state across multiple devices. In accordance with the techniques introduced here, a method includes steps running an instance of a computer application at an electronic device, and automatically determining a sync event that occurs in the electronic device. The sync event suggests a synchronization of application state data and the application state data represent an application state of the computer application at the sync event. The method further includes transmitting the application state data of the computer application to a storage server in response to the sync event. The application state data of the computer application enable another instance of the computer application to resume the application state at the sync event at another electronic device.

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The synchronization proceeds automatically on the background of the operating system of the device and is transparent to the user as well as the application. The user can stop operating on an instance of an application running on one device and resume another instance of the application running on another device at where he left off. The application state synchronization is achieved at the operating system level of the devices. There is no special treatment or design needed for the computer application itself. Any computer application capable of running on such an operating system can take advantage of the application state synchronization functionality.

Other aspects of the technology introduced here will be apparent from the accompanying figures and from the detailed description which follows.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects, features and characteristics of the present invention will become more apparent to those skilled in the art from a study of the following detailed description in conjunction with the appended claims and drawings, all of which form a part of this specification. In the drawings:

FIG. 1 illustrates an example system for application state synchronization between electronic devices.

FIG. 2 illustrates an example of an application states synchronization process across multiple electronic devices.

FIG. 3 illustrates an example operating system of an electronic device.

FIG. 4 illustrates an example of an application state data of a computer application collected by an operating system.

FIG. 5 illustrates an example of an application state synchronization process based on a user defined synchronization scheme.

FIG. 6 is a high-level block diagram showing an example of the architecture of a computer server, which may represent any computer running the database management system described herein.

DETAILED DESCRIPTION

References in this specification to "an embodiment," "one embodiment," or the like, mean that the particular feature, structure, or characteristic being described is included in at least one embodiment of the present invention. Occurrences of such phrases in this specification do not all necessarily refer to the same embodiment, however.

A method of application state synchronization across devices is described herein. For example, a user plays a game on his smart phone, and stops playing and turns off the screen of his smart phone. The state of the game application is synchronized between his smart phone and other electronic devices via a cloud system. He can pick up his tablet computer and continue to play the game from where he left off. The synchronization is not necessarily directly triggered by a user intervention. For instance, the synchronization can be automatically triggered when the screen of the smart phone is turned off, or the user closes the game on his smart phone. The synchronization proceeds automatically on the background and is transparent to the user. Furthermore, the cloud system can analyze various information, including device profile, user profile and user history, to determine state of which application is to be synchronized and which device the state is synchronized to.

FIG. 1 illustrates an example system for application state synchronization between electronic devices. The system includes a cloud storage service 110 configured to store state

data for applications. In one embodiment, the cloud storage service **110** can be a storage cluster having computer nodes interconnected with each other by a network. The storage cluster can communicate with other electronic devices via the Internet. The cloud storage service **110** contains storage nodes **112**. Each of the storage nodes **112** contains one or more processors **114** and storage devices **116**. The storage devices can include optical disk storage, RAM, ROM, EEPROM, flash memory, phase change memory, magnetic cassettes, magnetic tapes, magnetic disk storage or any other computer storage medium which can be used to store the desired information.

A cloud synchronization interface **120** can also be included to receive data to be stored in the cloud storage service. The cloud synchronization interface **120** can include network communication hardware and network connection logic to receive the information from electronic devices. The network can be a local area network (LAN), wide area network (WAN) or the Internet. The cloud synchronization interface **120** may include a queuing mechanism to organize the received synchronization data to be stored in the cloud storage service **110**. The cloud synchronization interface **120** can communicate with the cloud storage service **110** to send requests to the cloud storage service **110** for storing application state data and retrieving data.

An electronic device **130** includes an operating system **132** to manage the hardware resources of the electronic device **130** and provide services for running computer applications **134**. The computer application **134** stored in the electronic device **130** require the operating system **132** to properly run on the device **130**. The electronic device **130** can backup application states of the computer applications **134** to the cloud storage service **110**. The electronic device **130** includes at least one local storage device **138** to store the computer applications, application data, and user data. The electronic device **130** can synchronize the application state data with the cloud storage service **110** via the cloud synchronization interface **120**. The electronic device **130** or **140** can be a desktop computer, a laptop computer, a tablet computer, an automobile computer, a game console, a smart phone, a personal digital assistant, or other electronic devices capable of running computer applications, as contemplated by a person having ordinary skill in the art.

The computer applications **134** stored in the electronic device **130** can include applications for general productivity and information retrieval, including email, calendar, contacts, and stock market and weather information. The computer applications **134** can also include applications in other categories, such as mobile games, factory automation, GPS and location-based services, banking, order-tracking, ticket purchases or any other categories as contemplated by a person having ordinary skill in the art.

The operating system **132** of the electronic device **130** includes a state synchronization module **136** to backup application state information from the local storage. The state synchronization module **136** can operate to keep the application state data from the electronic device **130** in synchronization with the cloud storage service **110** and other devices.

Similarly, another electronic device **140** can also synchronize the application state with the cloud storage service **110**. The electronic devices **130** and **140** can synchronize the application states between each other via the cloud storage service **110**. For instance, the electronic device **130** can synchronize the application state of a computer application to the cloud storage service **110**. The cloud storage service **110** communicates with the electronic device **140** to know that the electronic device **140** also contain this computer application

and the application state of this computer application is not updated on the electronic device **140**. In turn, the cloud storage service **110** sends the application state data to the electronic device **140**. Thus, the application state of this computer application is synchronized between the electronic devices **130** and **140**.

In one embodiment, the synchronization for backups from the electronic devices **130** and **140** to the cloud storage service **110** may take place on a configurable periodic basis, such as an hour or a day. In other words, the synchronization is scheduled to take place on a periodic basis. The scheduled synchronization can also check for updates that can be sent from the cloud storage service **110** to the electronic devices **130** and **140**.

Another type of synchronization can be a triggered when an event occurs on the electronic device **130** or **140**, and then the state synchronization module can initialize the application state data synchronization with the cloud storage service **110**. The triggered synchronization does not need the intervention from the user. For instance, a user turns off the screen of the electronic device **130**. The screen turning off event can trigger an application state data synchronization with the cloud storage service **110** as well as other electronic devices. However, the user does not need to specifically instruct the device to synchronize; the user does not even need to realize that the synchronization occurs.

In one embodiment, the sync event can be any of the following events: the screen of the electronic device being turned off, the instance of the computer application being closed, the instance of the computer application being paused, the instance of the computer application having been run continuously for a preconfigured period of time, the instance of the computer application being switched by another application, the instance of the computer application being switched from the foreground to a background of the operating system, a battery level of the electronic device being below a preconfigured value, the electronic device turning off, the electronic device switching to standby mode, a clock of the electronic device reaching a preconfigured time of day, and the electronic device being in a preconfigured location.

In one embodiment, the synchronization can be a delta synchronization where the electronic device **130** or **140** detects a change (i.e. delta) of application state data and only the changed data or difference are synchronized to the cloud storage service **110**.

Any electronic device running an operating system having the state synchronization module can initialize the application state synchronization. In addition, the cloud storage service **110** can also initialize the application state synchronization. In one embodiment, the cloud storage service **110** may analyze the electronic devices to determine which device is to be synchronized and state data of which application are to be synchronized.

FIG. 2 illustrates an example of an application states synchronization process across multiple electronic devices. At step **205**, a cloud storage system identifies a plurality of electronic devices capable of synchronizing application state data with the cloud storage system. The electronic devices may be capable of communicating with the cloud storage system via a network, such as the Internet, a WiFi Network, or a cellular phone network. At step **210**, one of the identified electronic devices runs an application.

At step **215**, a sync event is determined to occur at the electronic device. The operating system of the electronic device automatically determines the sync event, without the intervention from the user. The user does not specifically

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instruct the sync event. The user does not even need to realize the sync event. There is no need for a sync button, a sync gesture, a sync menu item, or a sync command. In other words, the operating system of the device makes the determination of a sync event. For instance, the operating system may recognize an event of the screen being turned off as a sync event. The operating system may also recognize an event of a running application being closed or being switched by another application as a sync event. The operating system may further recognize an event of a system standby as a sync event. The operating system of the device can determine other types of sync events, as contemplated by a person having ordinary skill in the art.

Once the operating detects a sync event, the operating system of the electronic device uploads the application state data of the computer application onto the cloud storage system at step 220. The operating system of the device may decide to immediately start uploading the application state data after the sync event, or start the upload a certain amount of time after the sync event. For instance, if the electronic device detects that there is another electronic device of the same user in a very close proximity, the operating system of the device may decide to start the upload immediately because of a high possibility that the user will start using the other device soon. In another embodiment, the electronic device may decide to start the upload at a certain time of day or at certain location. For instance, the electronic device may decide to start the upload at midnight 12 AM and at the user's home (determined by GPS location or WiFi location), so that the upload of the application state data does not intervene with normal operation of the device.

In one embodiment, the developer of the computer application does not need to specifically write any implementation for uploading the application state data. For example, there are no API calls embedded in the computer application for the application state data. The state synchronization module of the operating system is responsible for monitoring, collecting and uploading the application state data. In some embodiments, the state synchronization module compares the current application state on the device and the application state already stored in the cloud storage service. If the current application state is newer than the application state stored in the cloud storage service, the state synchronization module determines a difference (i.e. delta) between the current application state data and the application state data stored in the cloud storage service. In this way, the state synchronization module only needs to upload the difference to the cloud storage service. The cloud storage service is responsible for incorporating the difference into the application state data already stored.

At step 225, the cloud storage system performs an analysis on the device profile, user profile and user history, to determine which device the state is synchronized to. For instance, in one embodiment, the cloud storage system determines the devices that the same user is using (e.g. the devices which have established the user's user account). In another embodiment, the analysis is based on usage pattern. For example, the cloud storage service can determine to synchronize the application state to devices that the user has been frequently used during a specific time period, e.g. a week. Or the cloud storage service can determine to synchronize the application state to devices on which the user has been running that computer application. In yet another embodiment, the analysis is based on a proximity algorithm. For example, the cloud storage service can determine to synchronize the application state to devices that are physically close to the device in step 210. The proximity may be determined by GPS locations, WiFi net-

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work locations, cellular networking locations or the combination thereof. In still another embodiment, the analysis is based on the types of applications installed on the devices. For example, the cloud storage service can determine to synchronize the application state to devices that have instances of that application installed, or devices that have similar applications installed. Furthermore, the analysis can be determined by a combination of the above techniques, as well as any other device or user information as contemplated by a person having ordinary skill in the art.

The same types of analysis disclosed in the previous paragraph are used in determining the priority of synchronization. For instance, if there are application state data for multiple applications in the cloud storage service to be synchronized. The cloud storage service may determine to synchronize the state data for one application because the user has been frequently using that application during a recent time period, e.g. a week. In one embodiment, the cloud storage service decides a priority list including a reference to the application state data for the computer application, wherein the priority list regulates the order of transmitting the application state data for the computer application and data for other applications based on the analyzing of the user profile and the hardware profiles of electronic devices.

In some embodiments, the analysis is performed after the cloud storage system receives application state data from a device. In some other embodiments, the analysis can be performed before the cloud storage system receives any application state data or before the sync event occurs.

At step 230, the cloud storage system sends the application state data to one or more devices that is identified by the analysis. The identified devices receive the application state data. Therefore, the instances of the application running on the devices are synchronized with the most up-to-date state. A user can run an instance of the application on any of these devices and the instance of the application resumes from the most up-to-date state. In one embodiment, the cloud storage system further sends an instruction to each of the identified devices to run an instance of the computer application by resuming the application state at the sync event at step 235.

In one embodiment, the application state data of a computer application may include application memory data, application local storage data, hardware configuration data, and user account configuration data. The state synchronization module of the operating system is capable of collecting these data and uploading the data as included in the application state data to the cloud storage service. Based on the application state data, an operating system of another electronic device can recreate the same environment and status of the application on the other electronic device.

In some embodiments, the electronic devices are capable of synchronizing application state data between each other via a network, such as a WiFi network, Bluetooth network, or a cellular phone network. Each of the electronic devices contains a network component configured to directly synchronize the application state data with another electronic device.

FIG. 3 illustrates an example operating system of an electronic device, according to one embodiment. The operating system 300 includes a kernel 304. The kernel 304 provides interfaces to hardware of the electronic device for the computer applications running on top of the kernel 304, and supervises and controls the computer applications. The kernel 304 isolates the computer applications from the hardware. The kernel 304 may include one or more intervening sources that can affect execution of a computer application. In one embodiment, the kernel 304 includes a network I/O module

306, a file I/O module 308, multi-threading module 310, user input 314, system interrupts 316, and shared memory access 318.

A state synchronization module 330 runs on top of the kernel 304. The state synchronization module 330 monitors the information from the intervening sources of the kernel 304 and records state data according to the information. In the example of FIG. 3, a computer application 340 includes a binary executable code 342 that can run on top of the operating system 300. The computer application 340 can further include static and dynamic libraries 344 that are referenced by the binary executable code 342 during application running. In one embodiment, the state synchronization module 330 runs in a user space file system (e.g. FUSE) on top of a Linux kernel. In another embodiment, the state synchronization module 330 runs in a kernel file system.

FIG. 4 illustrates an example of an application state data of a computer application collected by an operating system according to one embodiment. The application state data 400 of a computer application may include application memory data 402, application local storage data 404, hardware configuration data 406, and user account configuration data 408. In some other embodiments, the application state data can be all of or any combination of some of the fields 402, 404, 406 and 408. When the computer application is running, the state information in memory section (i.e. the application memory data 402) allocated for the application is being updated by the running application. The state synchronization module of the operating system monitors the application memory data 402, and uploads the data to a cloud storage service in response to the sync event. Furthermore, the computer application can update certain data on a local storage of the electronic device. The state synchronization module of the operating system can include the application local storage data 404 into the application state data 400. In some embodiments, the electronic device includes a memory device, e.g. flash memory, as both the memory and the local storage. Therefore, the application memory data 402 and application local storage data 404 can be one section of data that exists on the memory device of the electronic device.

The application state data 400 may further include hardware configuration data 406. For instance, the state synchronization module may record the current device sound volume level and the screen brightness level when the application is running. These device sound volume level and the screen brightness level are recorded as part of the hardware configuration data 406 and will be uploaded to the cloud storage service. Therefore, after another device is synchronized with the application state data and starts to resume running the application, the other device automatically adjusts the sound volume level and screen brightness level as on the previous device. Moreover, the application state data 400 may include user account configuration data 408. The user account configuration data 408 may include the user's preferences and choices regarding the computer application and the operating system environment for running the computer application. For instance, the user account configuration data 408 may include information about the user's language preference. Assuming the computer application is a game supporting both English and Chinese languages for user interface in the game, the user has selected the English language as the preferred language. The state synchronization module records the user's language preference as a part of the user account configuration data 408. The user account configuration data 408 is synchronized to another device via the cloud storage service. When the other device starts to resume running the

application, the application will use the English language for the game interface, as indicated by the user account configuration data 408.

In some embodiments, a user can define a synchronization scheme to control the way how and when the synchronization process performs. FIG. 5 illustrates an example of an application state synchronization process based on a user defined synchronization scheme. At step 505, a cloud storage service receives an instruction of a synchronization scheme from a user. The synchronization scheme includes rules of how and when the synchronization process performs. For example, in one embodiment, the synchronization scheme can define a synchronization rule between two electronic devices, a smart phone and a tablet computer, for application state of a game application. The synchronization rule specifies that one of the electronic devices start attempting to synchronize application state to the other device, as soon as the game application being closed or the screen of the device being turned off.

Assuming the smart phone is the current device running the game application, at step 510, the operating system of the smart phone checks whether the game application is closed by the user. If the game application is closed, the process continues to step 520. Otherwise, at step 515 the operating system of the smart phone continues to check whether the screen of the smart phone is turned off. If the screen is turned off, the process continues to step 520. Otherwise, the process goes back to check the status as in steps 510 and 520 in a predetermined time period.

At step 520, the smart phone uploads application state data of the game application to the cloud storage system. The schedule of the uploading can depend on a type and a speed of a connection between the smart phone and the cloud storage system. For instance the schedule can be determined so that the uploading is delayed to use a WiFi connection, to avoid the uploading using a cellular data connection (e.g. 3G or LTE). At step 525, the cloud storage system reads the synchronization scheme defined by the user. At step 530, the cloud storage system checks whether the other device, i.e. the tablet computer, is currently being connected with the cloud storage system. If the tablet computer is connected with the cloud storage system, the system sends the application state data to the tablet computer according to the synchronization scheme at 535. Otherwise, the cloud storage system continues to check the connection with the tablet computer on a periodic basis.

At step 540, when the user starts to use the tablet computer, the tablet computer starts to run an instance of the game application by resuming the application state recorded in the synchronized application state data.

FIG. 6 is a high-level block diagram showing an example of the architecture of a computer, which may represent any electronic device or any server within a cloud storage service as described herein. The server 600 includes one or more processors 610 and memory 620 coupled to an interconnect 630. The interconnect 630 shown in FIG. 6 is an abstraction that represents any one or more separate physical buses, point to point connections, or both connected by appropriate bridges, adapters, or controllers. The interconnect 630, therefore, may include, for example, a system bus, a Peripheral Component Interconnect (PCI) bus or PCI-Express bus, a HyperTransport or industry standard architecture (ISA) bus, a small computer system interface (SCSI) bus, a universal serial bus (USB), IIC (I2C) bus, or an Institute of Electrical and Electronics Engineers (IEEE) standard 1394 bus, also called "Firewire".

The processor(s) 610 is/are the central processing unit (CPU) of the server 600 and, thus, control the overall opera-

tion of the server 600. In certain embodiments, the processor(s) 610 accomplish this by executing software or firmware stored in memory 620. The processor(s) 610 may be, or may include, one or more programmable general-purpose or special-purpose microprocessors, digital signal processors (DSPs), programmable controllers, application specific integrated circuits (ASICs), programmable logic devices (PLDs), trusted platform modules (TPMs), or the like, or a combination of such devices.

The memory 620 is or includes the main memory of the server 600. The memory 620 represents any form of random access memory (RAM), read-only memory (ROM), flash memory, or the like, or a combination of such devices. In use, the memory 620 may contain a code 670 containing instructions according to the techniques disclosed herein.

Also connected to the processor(s) 610 through the interconnect 630 are a network adapter 640 and a storage adapter 650. The network adapter 640 provides the server 600 with the ability to communicate with remote devices, over a network and may be, for example, an Ethernet adapter or Fibre Channel adapter. The network adapter 640 may also provide the server 600 with the ability to communicate with other computers. The storage adapter 650 allows the server 600 to access a persistent storage, and may be, for example, a Fibre Channel adapter or SCSI adapter.

The code 670 stored in memory 620 may be implemented as software and/or firmware to program the processor(s) 610 to carry out actions described above. In certain embodiments, such software or firmware may be initially provided to the server 600 by downloading it from a remote system through the server 600 (e.g., via network adapter 640).

The techniques introduced herein can be implemented by, for example, programmable circuitry (e.g., one or more microprocessors) programmed with software and/or firmware, or entirely in special-purpose hardwired circuitry, or in a combination of such forms. Special-purpose hardwired circuitry may be in the form of, for example, one or more application-specific integrated circuits (ASICs), programmable logic devices (PLDs), field-programmable gate arrays (FPGAs), etc.

Software or firmware for use in implementing the techniques introduced here may be stored on a machine-readable storage medium and may be executed by one or more general-purpose or special-purpose programmable microprocessors. A “machine-readable storage medium”, as the term is used herein, includes any mechanism that can store information in a form accessible by a machine (a machine may be, for example, a computer, network device, cellular phone, personal digital assistant (PDA), manufacturing tool, any device with one or more processors, etc.). For example, a machine-accessible storage medium includes recordable/non-recordable media (e.g., read-only memory (ROM); random access memory (RAM); magnetic disk storage media; optical storage media; flash memory devices; etc.), etc.

The term “logic”, as used herein, can include, for example, programmable circuitry programmed with specific software and/or firmware, special-purpose hardwired circuitry, or a combination thereof.

In addition to the above mentioned examples, various other modifications and alterations of the invention may be made without departing from the invention. Accordingly, the above disclosure is not to be considered as limiting and the appended claims are to be interpreted as encompassing the true spirit and the entire scope of the invention.

What is claimed is:

1. A computer-implemented method comprising:
 - running an instance of a computer application at an electronic device;
 - 5 automatically determining a sync event that occurs in the electronic device, wherein the sync event suggests a synchronization of application state data and the application state data represent an application state of the computer application at the sync event; and
 - 10 transmitting the application state data of the computer application to a storage server, in response to the sync event;
 - wherein the application state data of the computer application enable another instance of the computer application to resume the application state at the sync event at another electronic device,
 - 15 wherein the storage server receiving the application state data transmits the received application state data to a target electronic device from at least one second electronic device, wherein the at least one second electronic device being associated with a user who runs the computer application at the electronic device,
 - wherein the storage server further identifies a priority list including a reference to the application state data for the computer application, wherein the priority list regulates the order of transmitting the application state data for the computer application and other data based on frequencies of running the computer application at the at least one second electronic device.
2. The computer-implemented method of claim 1, wherein the sync event is not instructed by a user who is operating the instance of the computer application running at the electronic device.
3. The computer-implemented method of claim 1, wherein the sync event is an event of the screen of the electronic device being turned off.
4. The computer-implemented method of claim 1, wherein the sync event is an event from events including the instance of the computer application being closed, the instance of the computer application being paused, the instance of the computer application has been continuously running for a preconfigured period of time, the instance of the computer application being switched by another application, a battery level of the electronic device being below a preconfigured value, the electronic device turning off, the electronic device switching to standby mode, a clock of the electronic device reaching a preconfigured time of day, or the electronic device being at a preconfigured location.
5. The computer-implemented method of claim 1, wherein the electronic device is capable of transmitting the application state data to the storage server via a network.
6. The computer-implemented method of claim 5, wherein the network includes the Internet, a WiFi network, or a cellular phone network.
7. The computer-implemented method of claim 1, wherein the storage server belongs to a cloud storage service cluster.
8. The computer-implemented method of claim 1, wherein the step of transmitting includes:
 - immediately transmitting the application state data of the computer application to a storage server, in response to the sync event.
9. The computer-implemented method of claim 1, wherein the step of transmitting includes:
 - transmitting the application state data of the computer application to a storage server at a preconfigured time of day or when the electronic device is at a preconfigured location, in response to the sync event.

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10. The computer-implemented method of claim 1, wherein the step of transmitting includes:

transmitting the application state data of the computer application to a storage server at a schedule depending on a type and a speed of a connection between the electronic device and the storage server, in response to the sync event.

11. The computer-implemented method of claim 10, wherein the schedule is determined so that the transmitting is delayed to use a WiFi connection, to avoid the transmitting using a cellular data connection.

12. The computer-implemented method of claim 1, wherein the step of transmitting includes:

transmitting a difference between the application state data of the computer application and previously transmitted application state data to a storage server, in response to the sync event.

13. A computer-implemented method comprising:

receiving application state data from a first electronic device, wherein the application state data represent an application state at a sync event of a computer application running at the first electronic device;

analyzing a user profile for a user who runs the computer application at the first electronic device and at least a second electronic device;

determining a target electronic device from the at least one second electronic device based on the analyzing of the user profile and the at least one second electronic device; deciding a priority list including a reference to the application state data for the computer application, wherein the priority list regulates the order of transmitting the application state data for the computer application and other data based on frequencies of running the computer application at the at least one second electronic device; and

transmitting the application state data to the target electronic device, wherein the application state data enable another instance of the computer application to resume the application state at the sync event at the target electronic device.

14. The computer-implemented method of claim 13, wherein the step of analyzing includes:

identifying an electronic device other than the first electronic device, the electronic device having established a user account of the user who runs the computer application at the first electronic device.

15. The computer-implemented method of claim 13, wherein the step of analyzing includes:

identifying an electronic device other than the first electronic device, wherein the user has run an instance of the computer application on the electronic device.

16. The computer-implemented method of claim 13, wherein the step of analyzing includes:

identifying an electronic device other than the first electronic device, wherein the user has used the electronic device for a predetermined number of times within a predetermined time period.

17. The computer-implemented method of claim 13, wherein the step of analyzing includes:

identifying an electronic device being in proximity of the first electronic device.

18. The computer-implemented method of claim 13, wherein the step of analyzing includes:

identifying an electronic device other than the first electronic device, wherein the electronic device has installed

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an instance of the computer application or another computer application similar to the computer application on the electronic device.

19. The computer-implemented method of claim 13, further comprising:

instructing the target electronic device to run an instance of the computer application by resuming the application state at the sync event at the target electronic device.

20. An electronic device comprising:

a processor;

a memory storing instructions which, when executed by the processor, cause the electronic device to perform a process including:

running an instance of a computer application at the electronic device; and

automatically determining a sync event that occurs in the electronic device, wherein the sync event suggests a synchronization of application state and the application state data represent an application state of the computer application at the sync event; and

a network component configured to transmit the application state data of the computer application to a storage server, in response to the sync event;

wherein the application state data of the computer application enable another instance of the computer application to resume the application state at the sync event at another electronic device,

wherein the storage server receiving the application state data transmits the received application state data to a target electronic device from at least one second electronic device, wherein the at least one second electronic device being associated with a user who runs the computer application at the electronic device,

wherein the storage server identifies a priority list including a reference to the application state data for the computer application, wherein the priority list regulates the order of transmitting the application state data for the computer application and other data based on frequencies of running the computer application at the at least one second electronic device.

21. The electronic device of claim 20, wherein the application state data includes application memory data, application local storage data, hardware configuration data, or user account configuration data.

22. The electronic device of claim 20, wherein the computer application is a game application and the application state data includes game save data for the game application.

23. The electronic device of claim 20, wherein the sync event is an event from events including the screen of the electronic device being turned off, the instance of the computer application being closed, the instance of the computer application being paused, the instance of the computer application has been continuously running for a preconfigured period of time, the instance of the computer application being switched by another application, a battery level of the electronic device being below a preconfigured value, the electronic device turning off, the electronic device switching to standby mode, a clock of the electronic device reaching a preconfigured time of day, or the electronic device being a preconfigured location.

24. The electronic device of claim 20, wherein the step of determining includes:

automatically determining a sync event that occurs in the electronic device without user intervention, wherein the sync event suggests a synchronization of application

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state data and the application state data represent an application state of the computer application at the sync event.

25. The electronic device of claim 20, wherein the network component configured to transmit the application state data of the computer application to a storage server, in response to the sync event, without user intervention.

26. The electronic device of claim 20, wherein the storage server belongs to a cloud storage service that is capable of synchronizing the application state data with another electronic device.

27. The electronic device of claim 20, wherein the network component is further configured to synchronize the application state data with another electronic device.

28. A computer-implemented method comprising:

receiving application state data from a first electronic device, wherein the application state data represent an application state at a sync event of a computer application running at the first electronic device;

analyzing a user profile for a user who runs the computer application at the first electronic device and at least a second electronic device;

determining a target electronic device from the at least one second electronic device, based on the analyzing of the user profile and the at least one second electronic device;

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deciding a priority list including a reference to the application state data for the computer application, wherein the priority list regulates the order of transmitting the application state data for the computer application and other data based on the analyzing of the user profile and the at least one second electronic device; and

transmitting the application state data to the target electronic device, wherein the application state data enable another instance of the computer application to resume the application state at the sync event at the target electronic device.

29. The computer-implemented method of claim 28, wherein the step of analyzing includes:

identifying an electronic device other than the first electronic device, wherein the user has run an instance of the computer application on the electronic device.

30. The computer-implemented method of claim 28, further comprising:

instructing the target electronic device to run an instance of the computer application by resuming the application state at the sync event at the target electronic device.

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